The RTKA489204DK0000BU is an evaluation kit that facilitates testing of the RAA489204 Li-ion battery pack analog front-end ICs. The RAA489204 monitors cell voltage and temperature, and provides 14-bit digital values, cell balance control, and significant fault detection. The RAA489204 also contains daisy chain hardware to provide robust board-to-board communication.

The evaluation kit operates as a stand-alone monitor or, combined with additional boards, creates a daisy chained application. One board operating alone allows testing of up to 14-cell series-connected Li-ion battery packs by using a standard USB interface to a PC. Up to 30 boards cascade (with daisy chain communication from board-to-board) to test systems with up to 420 cells.

Specifications
This board is configured and optimized for the following operating conditions:

- $V_{BAT} = 12V$ to $65V$
- Cell voltage -5V to +5V (Note: No cell voltage can go below pack ground or above 65V.)
- External inputs ExT1 to ExT4 = 0V to 2.5V (external temperature measurement thermistors on board)
- Two GPIO ports to monitor temperature (default) or general-purpose input or output.

Board Contents
The RTKA489204DK0000BU evaluation kit contains:

- RTKA489204DE0000BU RevB evaluation board
- MCB_PS4_Z multi-cell power supply test board
- RTKA489204MIRCOZ communications board
- USB cable that connects PC to evaluation board
- One twisted pair daisy chain cable
- One RJ45 daisy chain cable

Features
- Supports both stand-alone and daisy chained configurations
- Daisy chain capacitively coupled (direct board-to-board or cable connected) or transformer coupled cable connected (capacitor or transformer selected by jumper)
- External cell balance operation
- Cell voltages monitored after balance resistor to meet safety fault detection goals.
- GUI provided export option for generation of detailed register, voltage, and/or SPI communications log files
- USB microcontroller dongle runs HID firmware for enumeration and communications with Windows platforms
- Evaluation kit includes a resistor divider power supply board for cell voltage generation

Board Requirements
The following instruments are required to perform testing:

- 63V/1A adjustable power supply
- Wires to connect power supply to MCB_PS4_Z board
- Precision multimeter
- Windows computer with USB port
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1. **Functional Description**

The RTKA489204DK0000BU evaluation kit in use with the associated GUI allows you to become familiar with the instructions, capability, and operation of the device. A single RAA489204 Li-ion battery manager IC supervises up to 14 series-connected cells. The device provides accurate monitoring, cell balancing, and extensive system diagnostics functions.

The kit enables you to activate and data log voltage and temperature measurements. Cell voltages are supplied using a resistor ladder network in the MCB_PS4_Z multi-cell power supply test board.

The RAA489204 has three cell balancing modes incorporated: Manual Balance mode, Timed Balance mode, and Auto Balance mode. The Auto Balance mode terminates balancing functions when a charge transfer value specified by the host microcontroller has been met.

**Note:** Cell balancing requires the removal of the MCB_PS4_Z multi-cell power supply test board and requires the attachment of either cells or a power supply with the capability of sourcing the cell balance current.

The PCB has the components populated for external cell balancing. The external balance circuit provides a balance current of 40mA at a cell voltage of 4V.

The RAA489204 communicates to a host microcontroller through an SPI interface and to other RAA489204 devices using a robust, two-wire daisy chain system. Using the evaluation kit requires no special settings to select between a stand-alone system and a daisy chain system, and no special settings are required to select the top device. The master daisy chain IC is selected by connecting the RTKA489204MICROZ board.

By default, the daisy chain is configured for capacitor coupled communication. By moving jumpers, the daisy chain communicates through transformer coupling. All the components for both capacitor and transformer coupling are provided on the PCB.

Connecting multiple Renesas boards allows you to set up communications and measurement capability of many packs and up to 420 battery cells. However, review the Quick Hardware Setup Guide because there are safety concerns as voltage levels increase with multiple packs.
Note: The RAA489204 is an industrial/commercial version of the Automotive ISL78714. For this reason, the RAA489204 uses the same GUI and bare evaluation board PCB as the ISL78714, so images of the GUI and PCBs within this document may include either product number. The RAA489204 is not intended for Automotive applications.

1.1 Software Installation

Note: The software version supplied with the kit only supports the RAA489204 device.

Install the GUI software with the following steps:

1. Unzip the RAA489204 User Interface Rev9.0 folder to the local drive.
2. Confirm that the folder contains:
   - RAA489204 user interface Rev9.0.exe
   - ISLABHIDDevice.dll
   - DeviceID.txt
   - LabVIEW85RuntimeEngineFull.exe
3. Install LabVIEW85RuntimeEngineFull.exe.
   The RAA489204 User Interface Rev9.0 is now available to use.

1.2 Quick Hardware Setup Guide

1.2.1 Single Board

Set up the hardware with the following steps:

1. Before connecting the power supply to the boards, set the power supply voltage to 49V (3.5V per cell). If there are fewer cells being tested, reduce the power supply voltage so that it equals 3.5V times the number of cells.
2. Connect and check the power supply to the MCB_PS4_Z board. The positive terminal is J5/J5A and the negative terminal is J6/J6A. Check that the voltages on the J2 connector are 3.5V from pin to pin. Ground should be on the pin labeled 0 or G.

   If there is no voltage on J2, check that the switches are all set to ON. Also, confirm that there is no jumper on JP2 of the MCB_PS4_Z board to select the 14-cell option, because this puts the proper voltage on the VBAT pin.
3. Disable the power supply output.
4. Connect RTKA489204DE0000BU connector J3 to the MCB_PS4_Z board connector J1. Check the jumpers and switches. Ensure the RTKA489204DE0000BU board is configured so that LEDEN contains a jumper.
5. For stand-alone operation, the Daisy jumpers can be removed or connected to the CAP position (see Figure 2). Connect the microcontroller board (RTKA489204MICROZ) connector JP3 to the RTKA489204DE0000BU board connector JP6 (see Figure 3).

![Figure 2. Daisy Jumper Settings](image)
6. Turn on the MCB_PS4_Z power supply. Two green LEDs (V3P3 and V3P3x) turn on to indicate that the LDO regulators on the RAA489204 are operating.

7. Run the GUI (Follow Quick GUI Setup Guide to avoid connect issues!) Use the software to connect the board. Because there is a watchdog timer on the RAA489204 that waits close to a minute before powering down, perform the following steps with the GUI as soon as possible after powering the boards.
   a. Click Roll Call. Green indicator below it should light and # Devices should match the hardware setup. If it does not match, repeat this step after a short delay until # Devices matches the hardware setup.
   b. Click WDTM to MAX to set the watchdog timers to maximum.

8. When the RTKA489204DE0000BU is powered, there should be instances of the following board voltages:
   - V3P3 = 3.3V ±3%
   - VCC = ~3.3V ±5% (a little lower than V3P3)
   - V2P5 = 2.5V ±2%
   - VREF = 2.5005V ±0.5mV

9. Follow steps 10 and 11 in the Quick GUI Setup Guide to use the GUI to read the cell voltages.

10. Compare the voltages at the board input with the readings provided by the GUI. Use a meter to measure each of the cell voltages on the RTKA489204DE0000BU board J7 connector, because the MCB_PS4_Z board may not accurately divide the voltages into equal 3.3V steps. Also, measure the voltage from cell to cell, not cell to ground to get the best accuracy. The meter reading and the GUI readout voltages should closely match (within ±2.5mV at 3.3V and room temperature).
1.2.2 Daisy Chain

Set up the hardware with the following steps:

1. Before connecting the power supply to the boards, set the power supply voltage to 49V (3.5V per cell). If fewer cells are being tested, reduce the power supply voltage so that it equals 3.5V times the number of cells.

2. Connect the power supply to all MCB_PS4_Z boards in parallel, that is, all ground pins are tied together and all VBAT pins are tied together. See Figure 4 (Option A). This is not typical of a battery installation, where the ground of one board is the VBAT of another, but it easily facilitates testing of the communication and allows a safer environment for initial testing. Alternatively, power supplies can be stacked to better represent an actual implementation. See Figure 4 (Option B or C).

USE CAUTION when connecting the MCB_PS4_Z boards in series, because voltages quickly reach hazardous levels. BE CAREFUL!

A convenient and safe way to evaluate multiple daisy connected boards is to connect the ground pin of all MCB_PS4_Z boards together, so no board has more than 63V present.
There should be one MCB_PS4_Z board for every evaluation board. The positive terminal of the MCB_PS4_Z board is J5/J5A and the negative terminal is J6/J6A. Check that the voltages on the J3 connectors of all boards are 3.3V from pin to pin. Ground should be on the pin labeled “0” or “GND”.

3. Turn off the power to the power supply.
4. Connect each RTKA489204DE0000BU board connector J3 to an MCB_PS4_Z board connector J1.
5. Connect the daisy chain by using either capacitor isolation or transformer isolation.
   a. With capacitor isolation, the boards connect together directly (Figure 5) or with cables (Figure 6), or they connect using a combination of direct and cable connections.

**CAUTION**: STACKING POWER SUPPLIES RESULTS IN DANGEROUSLY HIGH VOLTAGE.

---

**A: Preferred Test Connection**
This is the simplest and safest connection for initial testing, system evaluation or software review or generation, because it has the lowest voltage and minimum number of connection wires.

**B: Alternate Test Connection**
This alternative also keeps cell voltages within safe limits, but allows the evaluation of system performance with different voltages on each device input. This allows an analysis to more easily confirm that the RAA489204 devices are not all reading the same values.

**C: Battery Typical Connection**
This connection stacks power supplies to generate a pack voltage of up to 189V. This is an unsafe condition, so care is needed when working with this setup. It is also important to check on whether the supplies can handle terminal voltages this high above ground. This connection is not recommended, because it offers little benefit over connecting actual cells, in which case, the MCB_PS4_Z boards are not needed.

---

**Figure 4. RTKA489204DK0000BU Battery Cell Emulation MCB-PS4-Z Alternative Connections**
b. With transformer isolation, the boards are connected as shown in Figure 7. When using cables, connect the wires as shown in Table 1. (Note: The boards are configured to prevent both direct connection and twisted pair cable connection on the same port.)

Table 1. Daisy Chain Connection Using Cables

<table>
<thead>
<tr>
<th>Daisy Chain Board</th>
<th>RAA489204 DaisyDown</th>
<th>RAA489204 DaisyUp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master</td>
<td>NC</td>
<td>Connect to DaisyDown of board above</td>
</tr>
<tr>
<td>Middle</td>
<td>Connect to DaisyUp of board below</td>
<td>Connect to DaisyDown of board above</td>
</tr>
<tr>
<td>Top</td>
<td>Connect to DaisyUp of board below</td>
<td>NC</td>
</tr>
</tbody>
</table>

1. NC = No connection

6. Check the jumpers and switches on the boards. Because this is a daisy chain configuration, each board should be configured as follows:
   a. LEDEN contains a jumper.
   b. The master (the board connected to the RTKA489204MICROZ board) must have the DAISY DOWN jumpers removed or set to the CAP setting.
   c. For the Master UP jumpers and all other boards, the DAISY jumpers can be set as CAP or XFMR (transformer) coupling. See Figure 2.
      i. When the boards are daisy chained using the capacitor coupling, connect the boards directly together or with the provided twisted pair cables.
      ii. When the boards are daisy chained using the transformer setting, connect the boards using the RJ45 cables.


8. Turn on the power supply. The two green LEDs (V3P3 and V3P3x) turn on to indicate that the LDO regulators are operating on the RAA489204s.
   a. Run the GUI (follow Quick GUI Setup Guide to avoid connect issues!). Use the software to connect the board. Because there is a Watchdog timer on the RAA489204 that waits close to a minute before powering down, perform the following steps on the GUI as soon as possible after powering the boards.
   b. Click on **Roll Call**. The GUI should have a green indicator and show the number of connected boards. If it does not, repeat this step after a short delay until **# Devices** matches the hardware setup.
   c. Click on **Set WDT to MAX**. This sets the watchdog timers to a maximum setting so that there is time to evaluate the system.

9. When the RTKA489204DE0000BU is powered, there should be instances of the following board voltages:
   - V3P3 = 3.3V ±3%
   - VCC = ~3.3V ±5% (a little lower than V3P3)
   - V2P5 = 2.5V ±2%
   - VREF = 2.5005V ±0.5mV

10. Follow steps 10 and 11 in the Quick GUI Setup Guide to use the GUI to read the cell voltages.

11. Compare the voltages at the board input with the readings provided by the GUI. Use a meter to measure the voltages on the J7 connector on the RTKA489204DE0000BU boards, because the MCB_PS4_Z board might not accurately divide the voltages into equal 3.3V steps. Measure the voltage from cell to cell, not cell to ground to get the best accuracy. The meter reading and the GUI readout voltages should closely match (within ±2.5mV at 3.3V and room temperature).
Figure 5. RTKA489204DK0000BU RevB in 36-Cell Direct Connect Daisy Chain Configuration (Capacitor)

Note: No Daisy Cables are required when connecting the boards together as shown.

Power Supply 12V to 63V

Top Board Position Automatically Set

All Jumpers Set to "CAP" Position

Mid Board Position Automatically Set

All Jumpers Set to "CAP" Position

Master Set by Connection to RTKA489204MICROZ Board
Figure 6. RTKA489204DK0000BU RevB in 36-Cell Cable Connect Daisy Chain Configuration (Capacitor)
Figure 7. RTKA489204DK0000BU RevB in 36-Cell Cable Connect Daisy Chain Configuration (Transformer)

- **Power Supply 12V to 60V**
- **Top Board Position Automatically Set**
- **All Jumpers Set to “XFMR” Position**
- **Mid Board Position Automatically Set**
- **Down Jumpers Set to “CAP” Position or Removed Up Jumpers Set to XFMR Position**
- **Master Set by Connection to RTKA489204MICROZ Board**
- **To PC USB Port**
1.3 Quick GUI Setup Guide

1. Make sure that USB Micro cable is unplugged from RTKA489204MICROZ board and the power supply for the resistor ladder is disabled.

2. Open GUI

3. Click STOP GUI (Figure 8) in bottom left corner to properly stop the GUI. Do not click stop sign in upper left corner as this aborts the program and can cause a connection failure to the RTKA489204MICROZ board.

4. Connect the RTKA489204MICROZ board to the PC USB port.

5. Next, click the arrow in the upper left of the screen to restart the GUI (see Figure 8). The GUI firmware window shows the firmware revision, and the green LED on the microcontroller board is illuminated. If the green LED is not lit, go back to step 3.

6. Enable the resistor ladder power supply.

7. Within one minute of powering the boards, the boards must be identified, and the Watchdog timers must be reset.

   By default, the boards enter sleep close to one minute after no communications; although OK, this event complicates the initial power-up. If each RAA489204 board does not have two lit green LEDs, disable then re-enable the power supply.

8. There are two ways to initialize the devices in the daisy chain stack.
   a. GUI Revision 9 or later: Complete the following steps:
      i. Click on Connect. This step performs a Roll Call operation, sets the Watchdog timers on all devices to Max, and clears all Faults. For the first time powering the system, Connect might generate the pop up message: RAA489204 Device #1 Comm NACK. This message is OK; simply close the box by clicking OK.
      ii. Finally, click OK in the Initialization Complete box.
   b. GUI Revision 8: Perform the following steps in sequence:
      i. Click on Roll Call (Repeat this step after a short delay if necessary until # Devices matches the hardware setup)
      ii. Click on WDTM to Max
      iii. Click on Clear all Faults.

9. The box next to the Roll Call button indicates the number of boards connected in the daisy chain, but if this is not correct, repeat steps 8a or 8b. However, if the number of boards remains incorrect, repeat steps 3-8. See Questions and Answers if the problem continues.

10. Click the Scan Voltages button. (Note: Step 8 and 9 are a quick way to validate that the system is connected and operating correctly.)

11. Click the Read Volts button. The voltage values read in step 10 are displayed. See Figure 9 for a typical setup with three boards in the daisy chain.
2. Using the RAA489204 GUI

2.1 Main GUI Screen

Figure 9 shows the GUI Main screen. The primary control elements and commands are on the left. The tab structure (along the top) provides information about the operation of the pack, the setup of each device in the stack, and various other monitor functions. The two message windows at the bottom keep track of and display messages transferred between the GUI and the RAA489204. Finally, in the lower right of the Main screen is an area that allows you to test any specific command that is not provided by the GUI.

Note: In the upper right corner of the GUI screen is a box titled CRC Seed. This value for this revision of the RAA489204 silicon should always be 'FFFF'. If it is not, there can be problems with communication between the GUI and the devices.

Note: The RAA489204 is an industrial/commercial version of the Automotive ISL78714. For this reason, the RAA489204 uses the same GUI as the ISL78714, so images of the GUI within this document may indicate ISL78714. The RAA489204 is not intended for Automotive applications.

2.2 Main GUI Screen Operation

2.2.1 Start Up

When the program starts, the GUI opens the USB port and checks the revision of the microcontroller code on the kit dongle. To do this, the GUI sends a command to the microcontroller to read the firmware version number. This message is not passed along to the RAA489204.
2.2.2 Idle State
When there is no activity either in response to a user button press or from polling, the GUI is in the Idle state.
While in this state, the GUI monitors the USB port for unprompted responses from the RAA489204 evaluation board and microcontroller. If the USB buffer is empty, there is no action. If there is data in the USB buffer, the message is received and the decoded response is shown in a pop-up window.

Pressing any button causes the GUI to perform the operation of the button specified. During this operation, the Idle scan is suspended.

2.2.3 Message Recording
For every command sent and every response received, a record is placed in the Message Boxes. In one box, the messages are sent. In the other box, the messages are received. These both contain a Hex representation of the information. See examples in Table 2 and Table 3.

<table>
<thead>
<tr>
<th>Command</th>
<th>Message Sent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roll Call</td>
<td>80D0002E7D</td>
</tr>
<tr>
<td>Write WDT register</td>
<td>8691100B0100FF1EF0</td>
</tr>
</tbody>
</table>

Table 2. Messages Sent format

<table>
<thead>
<tr>
<th>Command</th>
<th>Message Recorded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roll Call</td>
<td>A4D001545A</td>
</tr>
<tr>
<td>Write WDT register</td>
<td>84D20184FE</td>
</tr>
</tbody>
</table>

Table 3. Messages Received format

2.2.4 Stop GUI
The STOP GUI button exits the program. This method is preferred for exiting the program (rather than clicking the stop sign icon in the menu bar), because it performs some clean-up in the USB connection to the microcontroller dongle.

2.2.5 Roll Call
Important: The roll call operation, or Connect, must be the first operation.

The Roll Call button sends a Roll Call command to the evaluation boards using a Roll Call command. No other commands work until the stack is identified.

The Roll Call command is made up of five bytes and is similar to most other commands.

For information on the structure of a command, see the RAA489204 datasheet.

The Roll Call command passes through each device in the daisy chain. The devices self identify, and the top device sends a Roll Call response back to the GUI. After receiving the response, the GUI knows the number of devices that are in the stack, inputs that value into the # Devices window, and illuminates the green USB Connect indicator.
If no devices (or fewer number of devices than expected) are identified following a press of the Roll Call button, complete the following steps:

1. Confirm that the cables are connected firmly and that the boards are powered. You should see two green LEDs illuminated on each board. If any board has only one LED illuminated, follow this procedure:
   a. If you either have (1) one evaluation board with one green LED or (2) a Master board with one green LED while the other boards have none, check to see that the switches on the MCB_PS4_Z boards are set to ON. Next, follow either step i or ii.
      i. Cycle the power on all of the evaluation boards.
      ii. Or, click the Wakeup/HReset Precursor button; next, click the Wake button. The master wakes up (both green LEDs on plus a red LED).
   b. Click Roll Call again.

2. If step 1 does not work, click STOP GUI. Next, click the arrow in the upper left of the screen to restart the GUI. See Figure 11. The GUI indicators change, and the green LED on the microcontroller board is illuminated.

3. If communications still do not work, check that the daisy chain jumpers are set correctly. The jumpers on the main board (the one connected to the microcontroller) should be set to CAP or removed for the DWN setting.

4. If step 3 does not work, power down the board, remove the USB connection, and reconnect everything (confirm that all connections are good) and power up again (connect one board for simplicity, if possible.)

5. If the problem persists, use a different board or contact Customer Support.

Figure 10. Roll Call Operation

Figure 11. Restarting the GUI
2.2.6  WDTM to Max

This button sends a message to every device in the stack to set the Watchdog timeout value to Maximum. This action is a good thing to do in an evaluation environment, because the default WDT value is about one minute. If no actions are taken during this time period, devices go to sleep.

The WDTM to Max button sends a series of individual write operations to set the maximum WDT value in the WDT/BAL TIME register in each device, see Figure 15. If nine devices are identified in the Roll Call command, this command is sent nine times, once for each IC.

At the end of each write operation, the GUI receives an ACK that it has received this command. If it does not, a pop-up window indicates the NAK response.

2.2.7  Clear All Faults

This button sends a message to every device in the stack to clear all of the Fault registers; this event consists of a series of individual Multi-register write operations to each device. Six contiguous registers present fault information. This button writes ones to all register bits (“0xFFFF”) in every Fault register to clear the faults.

If nine devices are identified in the Roll Call command, then this multi-register command is sent nine times, once for each board. At the end of each write operation, the GUI receives an ACK that it has received this command. If it did not, there is a pop-up window indicating the NAK response.

2.2.8  Connect

This button tells the GUI to perform the Roll Call, WDTM to Max, and the Clear All Faults commands in sequence. When running this command on a stack of boards directly after the board are powered, there might be an error message “RAA489204 Device #1 Comm NACK”. This is OK. Close this box by clicking OK. When this command is complete, an Initialization Complete pop up box appears. Click OK to close this box. During the operation, the message boxes show the various commands and responses associated with this operation.

The SPI Block Mode and Select DRDY Mode buttons allow you to set the SPI mode of operation as either Block transfer or Byte transfer. A Block transfer sets the SPI CS pin low at the start of an operation and brings it high at the end, regardless of how many bytes are in the data transfer. The Byte transfer mode brings the SPI CS line high between each byte. The GUI automatically controls the RAA489204 DRDY Mode pin to correspond to the chosen SPI mode selected.

To use these buttons, click SPI Block Mode to select the required mode, then click Select DRDY Mode to actually send the command to the microcontroller. No data is sent to the RAA489204 with this command.

2.2.9  Scan Volts

The Scan Volts button forces a Scan Volts command to all devices. The command uses an Address All device address.

2.2.10  Scan Mixed

The Scan Mixed button forces a Scan Mixed command to all devices. The command uses an Address All device address.

2.2.11  Scan Temps

The Scan Temps button forces a Scan Temperature command to all devices. This command uses an Address All device address.

2.2.12  Scan All

The Scan All button forces a Scan All command to all devices. In one operation, the command executes together the Scan Volts, Scan Wires, and Scan Temps commands, and the command
uses an Address All device address. The Scan All operation, when using the MCB_PS4_Z boards with the RTKA489204DE0000BU RevB boards, produces an Open Wire error on Cell1. This is a result of a voltage drop caused by the MCB_PS4_Z resistor divider, the input filter on the RTKA489204DE0000BU board, the open wire current, and the open wire threshold detection level on VC1. This combination produces a fault. Using a power supply or batteries to power the board prevents this fault condition during Scan All.

2.2.13  Read All Volts

The **Read All Volts** button successively reads the voltage values for all devices and puts the values into the table in the **General** tab. The GUI decodes the Hex values in the volts (except for the Fault Status, which remains in HEX).

2.2.14  Read Temps

The **Read Temps** button successively reads the temperature Values for all devices and inputs the values into the table in the **General** tab. The GUI decodes the Hex values into volts (except for both the Fault Status that remains in HEX and the Internal Temp value that is converted to °C).

2.2.15  Scan Wires

The **Scan Wires** forces a Scan Wires command to all devices. This command checks whether there are any open inputs. This command uses an Address All device address.

2.2.16  Scan Continuous

The **Scan Continuous** button sends a Scan Continuous command to all devices. The command uses an Address All device address.

2.2.17  Scan Inhibit

The **Scan Inhibit** button forces a Scan Inhibit command to all devices. The command uses an Address All device address.

2.2.18  Scan Cell MUX

The **Scan Cell MUX** button forces a Scan MUX command to all devices. This command uses an Address All device address.

2.2.19  Polling

Select the desired Scan Mode to be used when performing the polling operation. Select Scan Voltages, Scan Mixed, or Scan All using arrow keys or clicking on the options box.

Select the polling interval with the Polling (ms) value. If the polling operation takes more time than this setting, the polling essentially becomes continuous with a new operation starting after the previous one completes.

Click the **Start** button to start polling. While polling, the button illuminates and shows **Stop**. The data collected fills a data array that can be loaded to Excel when polling stops. Export the data by stopping the scan and then pressing **Save to Excel File**.

**Scan All** polling forces measurement of the cell voltages, Pack voltage, the temperatures, and checks for open wires. The **Scan All** command is sent one time for each polling loop to all stack devices using **Address All** addressing. Polling using Scan All generates an Open Wire fault on cell1. (See **Scan All**).

The **Scan Volts** option scans the cell voltages, the Pack Voltage and the internal temperature.

**Scan Mixed** polling is the same as the Scan Volts option, but it scans the ExT1 input midway through the Cell Voltage scan.
The polling operation follows the scan command with a read of voltages, faults, and temperatures. The operation
processes using read commands for each device to request the contents of the voltage, temperature, and fault
registers.

When the data is returned, the GUI extracts the information from the buffer to populate the screen and the data
collection array. When populating the display, the cell voltage, pack voltage, and internal temperature registers are
converted from the Hex value in the returned message to either a voltage or temperature for display. The external
temperature inputs are only converted to a voltage. Converting the External Temperature inputs to a temperature
value is decided by the user and is dependent on the external resistor/thermistor divider arrangement. See also the
RAA489204 datasheet, Data Registers section.

With fewer than 14 cells connected (and with the Cell Setup Register set to ignore the missing cells), the missing
cells are depicted with a blank (or a value of 0) in the results table. See Figure 12 for an example of a stack
of 9 boards.

<table>
<thead>
<tr>
<th>Device</th>
<th>VC1</th>
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Figure 12. Proposed General Tab Showing a 6-Cell, 10-Cell, 11-Cell, and 14-Cell Configurations

2.2.20 **Measure**

The **Measure** button sends a Measure command to tell the devices to
measure the voltage specified in the adjacent selection box. Use the
up/down arrows to select the item to measure, or better, click on the box to bring up a menu selection. The
Measure command uses an Address All device address.

2.2.21 **Sleep**

Clicking on the **Sleep** button sends a Sleep command. This command uses an Address All
device address.

2.2.22 **SReset**

The **SReset** button sends an SReset command. This command uses an Address All device
address. After sending an SReset command, it is necessary to go through the **Roll Call + WDTM to Max** (or Connect) sequence again.
2.2.23  Wakeup

The **Wakeup** button sends a Wakeup command. The command uses an Address All device address. The **Wake/Reset Precursor** command should be sent prior to a Wakeup command.

2.2.24  HReset

The **HReset** button forces an HReset command to all devices. This command uses an Address All device address. The **Wake/Reset Precursor** command should be sent prior to this command. After sending an HReset command, it is necessary to go through the Roll Call + WDTM to Max (or Connect) sequence again.

2.2.25  Wake/HReset Precursor

Clicking on the **Wake/HReset Precursor** button sends a Wake/HReset Precursor command to the Master device. This command goes only to the Master device (not to the daisy chain) and instructs the Master to wake up (if not already awake). It prepares the Master to properly send the next command. If the next command is not a Wake or HReset command, the host receives a NAK response.

2.2.26  Balance Enable

This button issues a Balance Enable command. This command starts the balance operation. (Balance does not start, unless it is setup using other registers). This command uses an Address All device address. This command set the BEN bit in the Cell Balance Setup register.

2.2.27  Balance Inhibit

This button issues a command that stops the balance operation. This command uses an Address All device address. This command clears the BEN bit in the Cell Balance Setup register.

2.2.28  ACK

This button sends an ACK command through the daisy chain. The command expects an ACK response and only uses the address of the selected device.

2.2.29  NAK

This button sends a NAK command through the daisy chain. The command expects an ACK response and only uses the address of the selected device.

2.2.30  Calc Register Checksum

Clicking on this button sends a command to perform a calculation of the register checksum. The command expects an ACK response and uses an Address All device address. Typically, this command is used to update the register checksum following a change to settings in the volatile memory area that controls fault monitoring, such as changes to the overvoltage, undervoltage, and external temperature limits.

2.2.31  Check Register Checksum

Clicking on this button sends a command to perform a check of the register checksum. The command expects an ACK response and uses an Address All device address. If there is an error, that is, if the checksum returned from this operation does not match the calculated checksum, a Fault condition is set automatically. Read the Fault Status registers to see the fault condition.
2.2.32 Manual Read/Write

The Manual Read/Write section allows you to create your own command by setting the Device Address, Page Address, Data Address, Length, and Frame. Click **Manual Read** or **Manual Write**, and the GUI calculates CRC values, completes the command, and sends it across the USB port to the RAA489204.

**Note:** This manual operation only performs reads or writes on a single register and does not do error checking, so it is possible to read and write registers that are not defined. Renesas recommends against experimenting in this way, though there are no known problems associated with actions involving undefined registers.

---

2.3 Fault Status Tab

The Fault Status tab holds the contents of the Cell Setup, Scan Count, and Fault registers.

To set bits 2 to 14 in the Cell Setup register, click on the bits to set, and click **Write**. Bit 1 cannot be set. This disables the selected cells from the scan operation.

The Scan Count bits cannot be set or cleared. These are indications only (despite the Write button next to this register.)

The Fault Status Register bits (except PAR, OW, UV, OV, OT, and BUFERR), all of the bits in the OV Fault, UV Fault, OW Fault, OT Fault, and the General Fault registers are cleared by clicking on the Write button on each register or by using the Write Page button. The bits are cleared by writing a “1” back to the bit that is set to “1”.

The PAR, OW, UV, OV, OT, and BUFERR bits are simply a logical OR of the respective bits in the other registers.

![Figure 13. Fault Status Tab Layout](image)

The bits in the Fault Registers can also be set to a “1” by setting the bit in the register, clicking on the **Override Clear on Write** button, and clicking on the **Write** button for that register. The **Clear Override on Write** button must precede each register **Write** where a bit is set to “1”. The write command cannot be the **Write Page** button.
The PAR, OW, UV, OV, OT, and BUFERR bits cannot be set by this sequence of operations. To set these bits, set the underlying bits in their respective registers.

Because these operations are for a single device only, the Daisy Chain Device Number must first be selected at the upper right in the window.

2.4 Fault Setup Tab

The registers shown in Figure 14 configure and monitor the Fault operation of the device.

Because these operations are for a single device only, the Daisy Chain Device Number is selected at the upper right in the window.

The registers on this page can all be read or written individually, with the Read button or Write button on the right, or together, using a Read Page or Write Page buttons.

For a Page Read/Write, the GUI handles the details, but since all the registers are in contiguous locations, the GUI uses a multi-register read operation, reading all registers in a single operation. The Write Page operation performs a separate write for each register. This could have been done using a single write command but was not implemented in this GUI.

Performing a Read operation returns the value(s) of the register(s). The contents of each bit are shown as indicators as well as in the value box provided at the right. The bit indicators and the value are also inputs, so you can click on a bit to change the setting or write a new value in the box. Then, clicking the Write button sends the command to the device. For registers that set voltage thresholds, the value in the box is decoded from the hex value. To change a voltage threshold, it is necessary to change the bit values to see the voltage reflected in the box at the right. It is not possible to directly write the voltage in the box.

2.5 Cell Balance and Setup Tab

Use the registers shown in Figure 15 to configure the Device Setup parameters and some of the Cell Balance parameters of the device. These registers also include CB enabled status and the device Serial Number.

Because these operations are for a single device only, the Daisy Chain Device Number is selected at the upper right in the window.

As with other tabs, each bit has an indicator/control and there is a value box on the right. For registers that are Read only, there is no Write button on the right, and a Write Page skips these registers.
2.6 CB Value 1 Tab

The registers shown in Figure 16 are used to configure the Cell Balance operation of the device. Because these operations are for a single device only, the Daisy Chain Device Number is selected at the upper right in the window.

As with other tabs, each bit has an indicator/control, and there is a value box on the right.

2.7 CB Value 2 Tab

The registers shown in Figure 17 are used to configure the Cell Balance operation of the device. Because these operations are for a single device only, the Daisy Chain Device Number is selected at the upper right in the window.

As with other tabs, each bit has an indicator/control, and a value box is on the right.
2.8  CB Status Reg 1 Tab

The registers shown in Figure 18 are used to configure the Cell Balance operation of the device.

Because these operations are for a single device only, the Daisy Chain Device Number is selected at the upper right in the window.

As with other tabs, each bit has an indicator/control, and a value box is on the right.

When changing the cells that are being balanced in Manual Mode, (1) send a Balance Inhibit command; (2) change the contents of the CB Status Register 1; and (3) click on Balance Enable.

2.9  CB Status Reg 2 Tab

The registers shown in Figure 19 are used to configure the Cell Balance operation of the device.

Because these operations are for a single device only, the Daisy Chain Device Number is selected at the upper right in the window.

As with other tabs, each bit has an indicator/control, and a value box is on the right.
The registers shown on Figure 20 provide access to some of the User Registers, the EEPROM checksum registers, and some miscellaneous registers. All of these registers are volatile, meaning that when the device is reset, the values are reset to default conditions.

Because these operations are for a single device only, the Daisy Chain Device Number is selected at the upper right in the window.

Registers without a Write button are read only.

As with other tabs, each bit has an indicator/control, and a value box is on the right.
3. RTKA489204DE0000BU Evaluation Boards

3.1 PCB View

![Figure 21. Top View](image1)

![Figure 22. Bottom View](image2)
3.2 Schematics

3.2.1 RTKA489204DE0000BU

Figure 23. RTKA489204DE0000BU RevB Board Block Diagram

- Front End
  - AFE.Sch
- Cell Balance
  - CBAL.Sch
- Communications
  - Comm.Sch
- Microcontroller board
- Connections
  - BatCon.Sch

Two External Temperature board options:
1) 6 thermistor
2) 16 thermistor

These plug into the same Unshielded twisted Pair (2 pin Molex connectors) or Shielded or Unshielded Ethernet Cable (8 pin RJ45 connectors) (note: Shielded cable only for use when boards are populated with Daisy Transformer isolation.)
Figure 24. RTKA489204DE0000BU RevB Board AFE Schematic

- **R20, R21**: 1W each

  At 60V and 25degC, 20mA load on V3P3X is ~40mW dissipation in 100 Ohm and ~1.05W in Q2. This is about the max rating of Q2.

- **R28, R29, C24, C25, Th5, and Th6**: are DNP for GPIO operation and populated for Temp sense.

- **At 85degC ambient, the power dissipation of Q1, Q2 is ~0.55W. At 60V, the max current should be limited to ~10mA.**
Figure 25. RTKA489204DE0000BU RevB Board Cell Balance Schematic
Figure 26. RTKA489204DE0000BU RevB Board Communications Schematic
Figure 27. RTKA489204DE0000BU Board Battery and Power Supply Connection Schematic

Changes: Rev B:
- Input Resistors changed (PACK) to 499 Ohm (VBAT) to 100 Ohm
- 0 Ohm resistors added between VBAT and VC12, and between VSS and VC0
- VBAT cap changed to 220nF

J3 = Sullins, P/N: STC02SYAN
- Mates to PCB Socket, Sullins P/N: NPTC171LGBN-RC
- or, Mates to cable connector, Molex P/N: 0050579017
- or, Mates to cable connector, TE Connectivity P/N: 3-67499-2

J3 = TE Connectivity (R/A connector), P/N: 6-104935-6
- Mates to cable connector, TE Connectivity P/N: 1-104257-6

Cable wire 3M 8124 Series
- Cable Pins: TE Connectivity: P/N: 1-104488-7
- Cable Pins: Molex: P/N: 0016020086
3.2.2 RTKA489204MICROZ

Figure 28. RTKA489204MICROZ RevD Microcontroller Schematic
3.2.3 MCB_PS4_Z Power Supply

Figure 29. MCB_PS4_Z Power Supply Board Schematic

J6 and J7 = 0.1 spacing breakaway straight jumpers (primary) or J6 and J7 = TE Connectivity: P/N: 6-103669-6
### 3.3 Bill of Materials

#### 3.3.1 RTKA489204DE0000BU RevB Evaluation Board

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<td>ERJ-6ENF2000V</td>
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<td>TE Connectivity</td>
<td>FSMSMTR</td>
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<td>Renesas</td>
<td>RAA489204ANZ</td>
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### 3.3.2 RTKA489204MICROZ RevE Microcontroller Board

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<td>Imagineering Inc</td>
<td>RTKA489204MICROZREVEPCB</td>
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<tr>
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<td>Osram</td>
<td>LSL29K-G1J2-1-0-2-R18-Z</td>
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### MCB_PS4_Z RevA Power Supply Board

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#### Qty Reference Designator Description Manufacturer Manufacturer Part

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<td>E-Switch</td>
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4. PCB Layout

Figure 30. RTKA489204DE0000BU RevB Top Overlay

Figure 31. RTKA489204DE0000BU RevB Bottom Overlay
Figure 32. RTKA489204DE0000BU RevB Top Layer

Figure 33. RTKA489204DE0000BU RevB Bottom Layer
4.1 PCB Design Guidelines

Figure 25 and Figure 27 (battery connection circuits) show that the first stage of the input filter provides protection against transients and EMI for the cell inputs. The circuits carry the loop currents produced by EMI and should be placed as close to the connector as possible. The ground terminals of the capacitors should be connected directly to a solid ground plane. Do not use vias to connect these capacitors to the input signal path or to ground. Any vias should be placed in line to the signal inputs so that the inductance of these forms a low-pass filter with the grounded capacitors.

In Figure 26, the daisy chain components are shown at the right of the drawing. The components are split into two sections. Components to the right should be placed close to the board connector with the ground terminals of capacitors connected directly to a solid ground plane, which is the same ground plane that serves the cell inputs. Components to the left of this section should be placed as closely to the device as possible.

The battery connector and daisy chain connectors should be placed close to each other on the same edge of the board to minimize any loop current area.

This schematic identifies three grounds that are nominally referred to as noisy, measurement, and quiet grounds. The noisy ground carries the EMI loop currents and digital ground currents, and it consists of a significant ground plane. The quiet ground is used for decoupling of the $V_{CC}$ voltage and two of the three VSS pins. The measurement ground reference is for decoupling the external temperature inputs, the voltage reference, and the remaining VSS pin. The measurement ground is (an island) isolated from the other grounds except for the one connection point to the other grounds near the VSS pins.
The main reason for these connections is to isolate the IC ground from induced currents caused by EMI. The separation of Quiet and Measurement grounding (where the three VSS pins connect at different points on the ground plane) is to minimize, the effect of the IC ground current on the device measurements.

The circuits shown at the bottom of Figure 24 provide external temperature inputs; these inputs are designed to operate with on-board NTC thermistors. To facilitate the use of external thermistors, the circuits include a 49.9Ω series resistor and capacitors to ground. The filter helps protect the IC from ESD at the temperature pins. If external thermistors are required, either remove the on-board thermistors or replace them with 10k resistors.

Each of the external inputs has an internal pull-up resistor connected by a switch to the VCC pin whenever the TEMPREG output is active. This arrangement results in an open input being pulled up to the VCC voltage.

4.2 Component Selection

Certain failures associated with external components can lead to unsafe conditions in electronic modules, for example, a component connected between high energy signal sources that fail short. Such a condition can easily lead to the component overheating and to damage of the board and other components in its proximity.

In using external circuits, you must consider the RAA489204 capacitors that are connected to the cell monitoring inputs. These capacitors are normally protected by the series protection resistors, but they could present a safety hazard in the event of a dual point fault where both the capacitor and associated series resistor fail short. Also, a short in one of these capacitors would dissipate the charge in the battery cell if left uncorrected for an extended period. Renesas recommends selecting fail safe or open mode types for the input capacitors that connect directly to ground. An alternative strategy is to replace each of these capacitors with two devices in series, each with double the value of the single capacitor.

A dual point failure in the balancing resistors of Figure 25 and associated balancing MOSFET could also give rise to a shorted cell condition. In a production environment, Renesas recommends replacing the single balancing resistor with two resistors in series.

The layout of the RTKA489204DE0000BU board attempts the following:

- Minimize the placement of signals on inner layers that might exceed the voltage limits on the board. Specifically, these include the daisy chain signals on the cable side of the isolation capacitors. Inner layers do not have as much isolation as external layers.

- Minimize the placement on outer layers and the traces carrying signals to and from the RAA489204. This placement is to minimize the potential effects of EMC generated voltages.

- The area directly under the RAA489204 IC (on the top layer) is not immediately surrounded by a ground plane. However, the bottom layer does contain a ground plane. The absence of ground on the top layer under the IC is to minimize the effect of temperature induced stress on the IC during soldering.

- Extra space is allowed around the daisy chain signals that might experience higher voltages when the boards are cascaded, and extra space can minimize capacitance on the daisy chain signals.

4.3 Evaluation Board Design Details

In the RTKA489204DK0000BU evaluation kit:

1. The microcontroller board is split from the evaluation board.
   a. The microcontroller board is designed to automatically sets the connected evaluation board as the master. To do this, the mode select pin CMODE on the RTKA489204DE0000BU board is pulled up to ground when the µC board connects to the evaluation board. The position of other daisy chain devices is determined by the software Roll Call procedure.
   b. If the system uses an external controller, simply eliminate the Renesas microcontroller; eliminate the microcontroller when connecting an external microcontroller by connecting pins 9 and 10 together from the RTKA489204DE0000BU board at connector JP6. Also, if using an external controller, you must also connect the DATAREADY signal to the external microcontroller in addition to the SPI signals.
2. The CMR1 and CMR0 inputs are set to “1” by on-board resistors. These set the daisy chain speed to 1MHz. If slower speeds are required, these resistors need to change. Remember that changing daisy speeds requires changes to the capacitors in the daisy chain link. To switch to slower daisy chain speeds, check the datasheet for changes to the daisy chain capacitor values for the selected changes to the CMR resistors. These changes require removal and replacement of soldered components on the PCB.

3. Renesas recommends that the daisy chain clock speed remain at 1MHz for transformer coupled connections.

4. Daisy chain capacitor connected operation can be set up with direct board-to-board connection of the boards or with daisy chain cables. These connections use different circuits. The direct connection method mimics a solution where all components for different devices are on the same board. The cable connection circuits use the recommended components for off-board configuration.

5. The external MCB_PS4_Z board has power switches. These can be used to experiment with open wire conditions.

6. The power supply board (MCB_PS4_Z) to evaluation board connection provides direct connection to the RTKA489204DE0000BU board without a cable. If a cable connection between the evaluation board and a battery stack is needed, remove the J3 connector on the evaluation board and replace it with a different type. One recommended option for cable connection components is shown as follows:

   - Vendor: TE connectivity
   - PCB connector part number: 6-104935-6
   - Mates to cable connector part number: 1-104257-6
   - Cable connector pins part number: 1-104480-7
   - Cable wire: 3M 8124 series

7. The MCB_PS4_Z board was designed to allow connection of two 24V regulators. When two regulators connect, the evaluation board is powered by 48V. The connectors used have a break-before-make configuration, so removing or adding a second supply causes a power interruption and board reset.

8. This evaluation board monitors the cells after the cell balance resistor.

9. In this condition, turning on a cell balance input pulls the input voltage low, so monitoring that input returns near 0V. This configuration is preferred for safety coverage, because the system can check this voltage to confirm that the input circuit and cell balance components are working correctly. **Note:** Cell Balance operation is not possible when the evaluation board is powered by the MCB_PS4_Z board, because the cell balance current disrupts the voltage divider on the power supply board. To test cell balance operation (without connecting a power supply or batteries), the 0Ω resistors R3C to R16C can be removed. In this case, the balance LEDs show the balance operation, but the balance current is only the LED current (about 3mA to 4mA), which still changes the measured cell voltage by 300mA to 400mA, however, the input voltage does not go to zero.

10. The RTKA489204DE0000BU board has a resistor divider and thermistors on the board for external temperature measurement on ExT1 to ExT4, but not for GPIO1 and GPIO2. The resistor divider is set up for the specific Murata thermistor specified in the BOM. If it is required to connect thermistors off board, remove thermistors (Th1 to Th4) or replace them with resistors equal in value to the external thermistors. Also, if the external thermistors differ in room temperature resistance, it might also be necessary to replace the upper resistor in the divider (R24 to R27) with more appropriate valued ones.

11. If using the ExTn inputs for monitoring a voltage, remove the on-board thermistors (Th1 to Th4) and the upper divider resistors (R24 to R27). and apply a voltage (between 0V and 2.5V) directly to the pins on J8. Measurement happens in response to a Scan Temperatures command.

12. The GPIO pins can be used as inputs to monitor a voltage or outputs (to show internal signals). They can also be used as temperature inputs, but it would be necessary to add in the pull-up resistors (R28, R29) and (if required) thermistors (TH5 and TH6).
4.4 Questions and Answers

Q: When the GUI starts up it appears that nothing happens.

A: The most common problem encountered when setting up the boards is a connection error. When the GUI powers up correctly and connects to the microcontroller dongle, the green LED on the microcontroller board lights up. If it does not, click the STOP GUI button, then click on the arrow in the upper left of the GUI until it shows a multiple black arrow (see Figure 36.)

![Program Stopped and Program Running](image)

**Figure 36. Restarting the GUI**

If the green LED on the microcontroller board still does not work, try this step again, but press the microcontroller board reset button first.

When the LED on the microcontroller board is green, press the Roll Call button. If communication is successful, the indicator in the GUI turns green and the number of devices shows non-zero.

If you are still having trouble, check below:

Q: The LED on the microcontroller board shows green, but I still have no communication with the GUI.

A: Verify that the cables are connected properly.

- Make sure that the µC board is plugged into the evaluation board correctly.
- Check that the evaluation board is powered up (the Evaluation board should show two green LEDs.)
- When both LEDs turn on, the part is powered for about a minute, unless there is communication to the board. So, when both LEDs are on, click Roll Call on the GUI within one minute, then click Set WDT to Max to set the sleep timer to its maximum value.
- Check that the DAISY DOWN jumpers are set to CAP or disconnected.
- For a daisy chain configuration, make sure the daisy chain jumpers are set correctly on all boards for the board connect method chosen.
- Make sure that the daisy chain cables connect to the proper device. That is, the DaisyUp on one board connects to DaisyDwn on the one above. Make sure that the connections look like those in Figure 5, Figure 6, or Figure 7.
- Check that the VBAT voltages are all within specified limits.
- Check that the CRC Seed value in the upper right side of the GUI is set to ‘FFFF’.

Q: I expect to see two green LEDs illuminated on the board(s), but there is only one LED (or no LEDs) illuminated.

A1: If only one LED is on:
If the V3P3 LED is on, but the V3P3X LED is off, the device is most likely in a sleep state.

- Cycle the power on the evaluation boards. If the both LEDs turn on when doing this, then it is likely that the ICs were all sleeping,
- Or, press the DISABLE button on the evaluation board momentarily to disable, then re-enable, the part. If both LEDs come on, then it is likely that the device was in a sleep state.
- If there is only one evaluation board, or if there is only one green LED on the Master board, then check to see that the switches on the MCB_PS4_Z board is set to ON. (The master/standalone board LED might be on because of its connection to the microcontroller board, but the board may not be powered.)
- If there is only one green LED on the Master board, then check to see that the switches on the MCB_PS4_Z board is set to ON. (The master/standalone board LED might be on because of its connection to the microcontroller board, but the board may not be powered.)
- Click on the Wakeup/HReset Precursor button, followed by a click on the Wake button. This should wake the boards (both green LEDs on plus a red LED). The red LED would typically indicate a WDT timeout fault. If the LEDs turn on after this step, it is also an indication that the ICs were sleeping.
Click the **Wake/HRESET Precursor** button then click the **HRESET** button. If this works to restore communications, then it is likely a combination of devices sleeping and one or more devices in an unknown state.

If the attempts to wake the boards are not solved by the procedures above, check the voltage on the V3P3 and VREF pins. V3P3 should be 3.3V when operating or about 2.7V when asleep. VREF should be 2.5V when operating and off when asleep. If the voltages are different from these, then there could be a board problem and you should contact your Renesas representative.

**A2**: If both LEDs are off, the board is not powered or the LEDEN jumper is missing. Check that the MCB_PS4_Z board is connected to the Evaluation board and to a power supply and that the switches on the power supply board are set to ON. Check the voltage on the B pin on jumper J7. This should equal the external power supply voltage. If this voltage is good and if the LEDEN jumper is in place, there could be a board problem and you should contact your Renesas representative.

**Q**: I have three boards connected, but the GUI shows only two.

**A**: This indicates that there is a problem with the top board or the connection between the second and third boards. Check that the daisy cable connects to the proper place and that the jumpers are correct for the required connection. If this does not work, swap the cables between the three boards. If the GUI then shows only one board, there is a bad cable.

**Q**: I am trying to program set the Internal Balance bit, IBAL, but I cannot set it?

**A**: Unfortunately, the board connected is populated with an RAA489204 device that was factory programmed as external balance only. This should not be a problem, because this board was set up as an external balance board. re-configuring the hardware for internal balance would entail a lot of board changes and expose the RAA489204 to potential hot plug issues if the changes are done incorrectly. If an internal balance configuration is required, contact your Renesas representative.

**Q**: Communication has stopped, and the Roll Call operation does not work.

**A1**: There is a condition that can arise in which daisy chained boards go to sleep and the master device is reset (power cycled or EN toggled). In this case, it is necessary to perform a **Wakeup_HReset Precursor** command, followed by a **Wakeup** command before performing a Roll Call command to re-establish communications.

**A2**: If the host microcontroller and SPI software is customer specific and is not the dongle that comes from the kit, then try pressing and releasing the Disable button on the Master device and re-try Roll Call. If the SPI communications are too slow, it is possible the Master gets an extra byte in the buffer which prevents it from recognizing subsequent commands. If this solves the problem, this is an issue with the Master only, it is not necessary to reset.

### 4.5 Errata

At the time of release, there are no known errors in the design/operation of the evaluation board.
5. Typical Performance Charts

Unless noted: \( V_{\text{BAT}} = 30\text{V}, T_A = +25^\circ\text{C} \). The waveforms in Figure 37 through Figure 44 are based on signals captured by an oscilloscope, or they are from exported data from the RAA489204 GUI software and charted in Excel. Measurements are captured from three RAA489204 devices operating in daisy chain mode, and measurements are taken as time assigned as the x-axis, which provides information regarding the typical subsystem reading variation. Some graphs also provide device-to-device comparisons.

![Figure 37. SPI/Daisy Chain Full Roll Call Command and Response (3 Device Stack)](image)
Figure 38. SPI/Daisy Chain Roll Call Command

Figure 39. SPI/Daisy Chain Roll Call Response (3 Device Stack)
Figure 40. Evaluation Board Cell Voltage Scan - Board 1

Figure 41. Evaluation Board Cell Voltage Scan - Board 2
Figure 42. Evaluation Board Cell Voltage Scan - Board 3

Figure 43. Evaluation Board Pack Voltage Scan
Figure 44. Evaluation Boards RAA489204 Internal Temperature
6. Ordering Information

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<td>Evaluation Kit for the RAA489204</td>
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7. Revision History

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<td>1.02</td>
<td>Mar 9, 2022</td>
<td>Updated sections 1.2.1, 1.2.2, and 1.3 to help clarify the instructions.</td>
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<tr>
<td>1.01</td>
<td>Feb 28, 2022</td>
<td>Changed section 1.2.1 steps 3 and 8.</td>
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<td></td>
<td>Changed section 1.3 steps 1-7.</td>
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<tr>
<td>1.00</td>
<td>Sep 23, 2021</td>
<td>Initial release</td>
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